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INSECTICIDES AND FUNGICIDES

AT THE

I.G. FARBENINDUSTRIE PLANT, HÖCHST

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COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

RESTRICTED

INSECTICIDES AND FUNGICIDES AT THE I. G. FARBENINDUSTRIE PLANT, HÖCHST

Reported by

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RESTRICTED

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I. INTRODUCTION

A. Outline of trip: The undersigned, an investigator attached to the Medical Intelligence Branch, Office of the Chief Surgeon, Hq. USFET, was ordered on 30 June 1945 to proceed by aircraft to Frankfurt a/M and thence to Höchst (Target 24/4), Germany, for the purpose of investigating the I. G. Farbenindustrie plant at that location. The subjects covered in this investigation comprise insecticides and fungicides. No rodenticides were found at this target.

Upon arrival at Frankfurt on 5 July, the undersigned joined a CIOS team composed of Drs. Kleiderer, Conquest and Williams, who were investigating pharmaceutical products of the Höchst plant. The team was joined by Dr. Rice on 9 July. Investigation of the target was completed 13 July 1945.

B. Summary of Investigation: The insecticide known as "Gix" containing as the active ingredient 60% of 1-trichloro-2,2-bis (p-fluorophenyl) ethane, was investigated in considerable detail as to its composition, method of manufacture, action against several insect species, modes of application against houseflies, alleged advantages over DDT, and pharmacological action on warm-blooded animals and also on frogs.

The biological testing methods at the Höchst laboratories were generally poor, so that the results obtained are not at all conclusive. In discussions with Drs. Pfaff, Wagner and Lanz of the Höchst staff there was a tendency on their part to interpret their testing results as unduly favorable to the performance of "Gix" as compared to that of DDT. Their testing methods and procedures were definitely inferior to those employed by the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

Dr. Wagner carried out a few preliminary tests against the ox warble (Hypoderma lineatum) using applications of "Gix" or DDT preparations on cattle to prevent the flies from laying their eggs. No results could be obtained in field trials of his preparations, because of disruption caused by the war. The formulae of the preparations that he used are reported for what they may be worth.

Other insecticides investigated are as follows:

"Nirosan" containing 1,3,6,8-tetranitrocarbazole as the active ingredient.

"Dizan" containing N-(phenyldiazo) piperidine as the active ingredient.

An adhesive caterpillar bait known as "Raupenleim", for use on the bark of fruit trees to trap the larvae of the winter moth, was developed at the Höchst laboratories. Castor oil and resins unobtainable by Germany during the war were substituted largely by a mixture of chlorinated aliphatic hydrocarbons in the formulation of this caterpillar glue.

The following fungicides were investigated:

Name	Active Ingredient
"2317W"	1-Thiocyano-2,4-dinitrobenzene
"Brassicol" and "Tritisan 5"	Pentachloronitrobenzene
"Bulbosan"	1,3,5-Trichloro-2,4,6-trinitrobenzene
"Brassisan	1,2,4-Trichloro-3,5-dinitrobenzene

II. INSECTICIDES

1. Hö 2474 or "Gix"

a. Composition

The active ingredient is 60% 1-trichloro-2,2-bis (p-fluorophenyl) ethane, 20% "Lobauer Gasöl" (a petroleum fraction with initial boiling-point 240°C and 93% distilling up to 360°C) plus 20% of an emulsifying agent of the polyhydroxyethylated iso-octylphenol type.

The 1-trichloro-2,2-bis (p-fluorophenyl) ethane is a liquid boiling at 160-180°C under 8 mm pressure. It is made by condensing chloral acetal with fluorobenzene in the presence of chlorosulfonic acid. The chloral acetal is made by chlorinating diethyl acetal. The fluorobenzene is made by diazotizing aniline hydrochloride in anhydrous hydrogen fluoride.

b. Manufacture

(1) Fluorobenzene

Into a reaction vessel of 5 cu. m. capacity containing 3000 kg of hydrogen fluoride (97-100%) 1250 kg of aniline hydrochloride are introduced. Diazotization is accomplished by the addition of 720 kg of solid sodium nitrite, keeping the reaction mixture cooled to 10°C. The diazotized solution is then transferred to a 4.5 cu. m. reaction vessel equipped with a reflux condenser where slow decomposition is allowed to take place at 40°. After nitrogen has ceased to evolve the upper layer of fluorobenzene is drawn off into a 2 cu. m. vessel where

it is washed with alkali until neutral and then distilled. The excess HF in the reaction vessel is recovered by distillation from oleum (100% for use in the next batch reaction.

Yield of fluorobenzene: 700-750 kg (77-82% of theory)

(2) Chloral acetal

Into a 2 cu. m. enamel vessel containing 590 kg of diethyl acetal chlorine is added as fast as it is absorbed at a temperature of 20-50°C during the addition of the first 1000 kg of chlorine. The reaction mixture is then transferred to a ceramic reaction vessel when a second 1000 kg of chlorine are added while 270 kg of water are run in at the same time. The reaction temperature is held at 50-85°. A third 1000 kg of chlorine is added at a temperature of 90-95°. The finished reaction product solidifies at 12-15°. This is distilled into a cast-iron reaction vessel. 1150 kg of sulfuric acid (100%) are added and the mixture distilled at 90° through a condenser made of lead coils. The inside temperature of the vessel is raised to 130° at the end of the distillation.

Yield: 1380-1450 kg (62-65% of theory)

(3) Condensation of Fluorobenzene with Chloral Acetal

Into a 2 cu. m. cast iron vessel there is added 485 kg chloral acetal and 690 kg fluorobenzene. With stirring and good outside cooling 415 kg chlorosulfonic acid are introduced during 5 to 7 hours so that the reaction temperature does not exceed 12°. After the reaction has ended, it is stirred for an additional 12 hours. The reaction mixture is then run into a 7 cu. m. ceramic vessel containing 3000 kg water. It is heated to 100° by blowing in steam. On standing, an aqueous acid layer separates, which is drawn off and disposed of. The reaction product is washed twice with water and finally neutralized with 33% alkali. The product is then dried by applying a vacuum and heating to 60°.

Yield of clear anhydrous oil: 900 kg (85% theory)

(4) Formulation of "Gix"

The condensation product (900 kg) is mixed with 300 kg of wetting agent ("Igepal" or poly-hydroxyethylated iso-octyl phenol) and 300 kg of "Lobauer Gasöl" (petroleum boiling at 240-360°C) to give 1500 kg of "Gix".

(5) Modifications in Manufacturing Procedure

(a) Fluorobenzene

To prevent corrosion of the steel reaction vessels and condenser coils Dr. Lanz has proposed that instead of using aniline hydrochloride, aniline base and hydrofluoric acid be used to eliminate the HCl which is more corrosive to iron than HF. The use of condensers

made from VgA steel (Krupp) has also been proposed, as well as coating the condenser surfaces with carbon.

(b) Chloral Acetal

The diethyl acetal produced in the acetone-acetic acid Division was not of uniform quality. Instead, Dr. Lanz has proposed using as a starting material the half-acetal which is more easily prepared from acetaldehyde and ethanol.

(c) Condensation

Dr. Lanz has found that chlorosulfonic acid gives somewhat better yields (80-82%) of condensation product than when sulfuric acid is used. There is also a saving in the sulfuric acid consumed by this modification of the Bayer condensation.

c. "Gix" vs. DDT against Insects

(1) Terminology and Concentrations

The following terminology has been used at the Höchst laboratories:

(a) Gix	-Containing	60%	active	ingre-
(b) Fluorgesarol-	"	5%	"	dient
(c) Bromgesarol -	"	5%	"	"
(d) Gesarol -	"	5%	DDT	

The concentration of a preparation referred to in their entomological data means the concentration of the preparation used and not the concentration of active ingredient, unless other wise noted. Thus 1% Fluorgesarol is equivalent to 0.05% active ingredient; 0.1% Gix is equivalent to 0.06% active ingredient; 1.2% Gesarol is equivalent to 0.06% active ingredient (DDT).

(2) Contact Poison Experiments Against the Gipsy Moth

In general the effects of Flurogesarol and Gesarol as resulting in final kill after several days, was about the same for both preparations. The initial symptoms of loss of ability to crawl and climb were exhibited by fourth-instar larvae of the gipsy moth sooner when Fluorgesarol was used than with Gesarol at the same concentrations. The onset of symptoms was observed after several minutes when Fluorgesarol preparations were used while it required one or more hours using Gesarol. Two chambers were dusted respectively with Fluorgesarol diluted with talc 1:1 and with Gesarol also diluted with talc 1:1. The effect on fourth-instar larvae of the gipsy moth is given in the following table:

Preparation	Quantity	%Kill (in parenthesis %affected) after: 24 Hours	2 Days	3 Days	4 Days	5 Days
Fluorgesard. + talc (1:1)	2.5kg/ha*	50(50)	60(40)	---	90(0)	90(0)
	1.25kg/ha	20(30)	50(30)	60(20)	---	80(0)
Gesarol + talc (1:1)	2.5kg/ha	10(90)	50(50)	---	70(0)	90(0)
	1.25kg/ha	0(0)	10(10)	20(0)	---	20(0)

*ha-hectare=10,000 sq. meters

In another experiment the larvae were dusted respectively with Fluorgesarol and Gesarol:

Preparation	Concn.	%Kill (in parenthesis %affected) after: 24 hours	2 Days	3 Days	5 Days
Fluorgesard.	2%	100 (0)	---	---	---
	1%	100 (0)	---	---	---
Gesarol	2%	60 (0)	---	---	90(0)
	1%	40 (0)	80 (0)	90 (0)	100(0)

'3) Stomach Poison Experiments Against the Brown Tail Moth

Gesarol and Fluorgesarol respectively were sprayed on larvae of the brown tail moth (Goldafter) and also on their food in parallel experiments. The following results were obtained:

Preparation	Concn.	%Kill (Affected) After: 2 Days	3 Days	5 Days	10 Days
Fluorgesard.	1%	5 (95)	45(55)	100	---
Gesarol	1%	0 (50)	25(25)	100	---
Fluorgesarol	Mixed	70 (30)	90(10)	100	---
Gesarol	with food	10 (0)	20(20)	20(20)	80(0)

(4) Against the Grain Weevil

Fluorgesarol is faster-acting than Gesarol. After 10 days Gesarol gave 74% kill and 6% of the insects were unaffected. Fluorgesarol gave 100% kill in the same period. A Fluorgesarol preparation containing 3% active ingredient is as effective as Gesarol (5% active ingredient) according to a report received from the Biologische Reichsanstalt in Berlin.

(5) Against Cockroaches

The 3% active ingredient Fluorgesarol was just as effective as the 5% active ingredient Gesarol against Phyllodromia germanica and Periplaneta americana. There was no difference in the speed of action of Fluorgesarol and Gesarol at the same concentration.

(6) Against Schildläuse (Aspiodotus duplex)

Gesarol is ineffective against Schildläuse.

Using a preparation containing 40% 1-trichloro-2,2-bis (p-fluorophenyl) ethane, 25% acetone and 35% emulsifier an emulsion was made up containing 2% active ingredient and sprayed on over-wintered Zwetschenschildläuse. The spray was completely effective. A similar spray containing DDT (Gesarol) in the same concentration was ineffective. Control experiments using acetone and emulsifier only were likewise ineffective against this insect.

(7) Stomach Poison Experiments Against Houseflies

Curds (Quark) were sprayed with Fluorgesarol and Gesarol respectively. Houseflies were allowed to feed on the material thus treated. The results are given in the following table:

Preparation	Concn.	% Kill after 1 Day	2 Days	4 Days
Fluorgesarol	0.25%	66	95	100
	0.05%	53	100	100
Gesarol	0.25%	30	87	98
	0.05%	4	62	96

(8) Contact Sprays Against Houseflies

Houseflies confined in chambers were sprayed with petroleum solutions of Fluorgesarol and with Gesarol respectively. Results were as follows:

Preparation	Quantity Used	% Knockdown after 15 Minutes
5% Gesarol in petroleum	1 cc/cu. meter	66.1
	2 cc/cu. meter	69.9
5% Fluorgesarol in petroleum	1 cc/cu. meter	91.0
	2 cc/cu. meter	95.6

Water emulsions containing 2% and 3% active ingredient were tested as sprays in the same manner with the following results:

Preparation	Concn.	Quantity Used	% Knockdown after 15 Minutes			
			Exp.1	Exp.2	Exp.3	Exp.4
Gesarol emulsion	2%	1 cc/cu.meter	5.0	0.0	11.9	12.8
	3%	"	31.3	42.6	11.0	14.2
Fluorgesarol emulsion	2%	"	49.1	78.8	45.8	49.5
	3%	"	70.5	72.7	80.6	65.7

(9) As Residual Sprays Against Flies ("Fliegenfussgiftversuche")

Deposits of Fluorgesarol and of Gesarol respectively on the inside surface of glass jars were tested against houseflies. The quantity used per unit area was not given. Presumably an attempt was made to apply approximately equivalent amounts of the substances tested over the same surface. The number of flies used is not given for this or any of the other experiments. Results are reported as follows:

Preparation	Concn.	% Kill (Affected) after 48 Hours
Fluorgesarol	0.5%	98 (2)
	0.5%	78 (22)
Gesarol	0.5%	80 (20)
	0.5%	50 (50)

In the following tests, conducted in the same way, the time interval for the first fly to be knocked down and for the last fly to fall was observed:

Preparation	Concn.	Elapsed Time for Knockdown of: First Fly	Last Fly
Fluorgesarol	1%	11 Min.	40 Min.
	2%	9 "	35 "
Gesarol	1%	29 "	50 "
	2%	32 "	75 "

Emulsions containing the insecticide in a 10% lime suspension were found advantageous in prolonging the lasting effect of residual sprays. In the following experiment the chambers were tested against flies after 1, 14, 28 and 50 days. The time interval, after introduction of the flies into the chamber, for the first fly to fall is given in minutes. The time interval for the last fly to fall is also given in minutes in most cases, but in some cases where the knockdown of the last fly was unduly prolonged, it is given as a percentage knockdown during a stated time of observation. The data are as follows:

Preparation	Conn.	Elapsed Time for Knockdown of First fly/Last fly when Residue Tested After: 1 Day	14 Days	28 Days	50 Days
Gix (60% active ingredient) in 10% lime and water	0.1%	14'/27'	27'/260'	100'/57% in 1.8hrs.	0% in 3 hrs.
	0.5%	7'/13'	11'/21'	27'/76'	86'/54% in 9.5 hrs.
Cesarol (5% active ingredient in 10% lime and water	1.2%	26'/46'	31'/60'	30'/58'	62'/180'
	6%	50'/165'	38'/105'	35'/70'	39'/68'

The above results indicate that DDT (Gesarol) has a longer lasting action than the fluor-DDT (Gix).

(10) As Impregnated in Cloth Against Flies.
Acetone solutions of Fluorgesarol and of Gesarol respectively (each containing 10% of active ingredient) were used to impregnate strips of cloth which were then tested for their contact-action against flies up to six months' time after impregnation. The details of the technique used were not clearly given. Presumably the method employed was similar to the one used at Leverkusen (see report on Elberfeld and Leverkusen) to get all flies to walk on the treated cloth. The following results were obtained:

Preparation	Impregnated on	Elapsed Time in Minutes for Knockdown of First Fly/Last Fly when tested on: 22/12/42	17/3/43	10/5/43	7/6/43
Fluorgesarol	5/12/42	6'/22'	7'/27'	11'/40'	14'/65'
Gesarol	5/12/42	12'/32'	14'/40'	10'/38'	14'/40'

(11) As a Soil Insecticide Using Flies as Test Insects.
The insecticide was worked into soil in flower pots which were then placed in glass jars into which flies were introduced. It is claimed that Fluorgesarol in these tests was substantially longer-lasting than Gesarol when applied as a soil insecticide. In these experiments "Gesapon" (containing 3% DDT) obtained from the Geigy Co. was used to compare with Fluorgesarol at the same concentration. In the following table the results were obtained from soil impregnated on 16/12/43. Four liters of a water emulsion in the concentration indicated were used per cubic meter of soil:

Preparation	Concn.	Elapsed Time in Minutes for Knockdown of First Fly/Last Fly when Tested On: 11/12/43	10/1/43	31/1/43	1/3/44
"Gesapon" (cont'g. 3% DDT)	2%	25'/30'	195'/360'	0% in 3 hrs.	140'/300'
Fluorgesarol (cont'g. 3%fluor-DDT)	2%	14'/17'	60'/120'	115'/155'	65'/120'
Gesarol (cont'g. 3% DDT)	2%	18'/24'	300'/450'	0% in 3 hrs.	0% in 3 hrs.
Gix (cont'g. 60%fluor-DDT)	0.1%	9'/12'	45'/55'	36'/115'	35'/55'

Plant lice and several species of beetles were tested on the treated soil but the tests were unsuccessful and gave no clear results ("keine eindeutigen Ergebnisse")

(12) "Bromgesarol"

Dr. Pfaff stated in in several tests against flies, beetles, and cockroaches, Bromgesarol (the p-bromo-analog of DDT) was always somewhat inferior to Gesarol (DDT).

(13) Summary of Testing

The conclusions drawn by Dr. Pfaff and Dr. Wagner from the above results were given as follows:

(a) As an agricultural insecticide Fluorgesarol, because of its desirable physicalproperties, is superior to Gesarol at the same concentration of active ingredient because of its faster crippling and killing action.

(b) In many cases Fluorgesarol at a concentration of 3% active ingredient is equivalent to Gesarol containing 5 and 6% active ingredient.

(c) Fluorgesarol has less long-lasting action than Gesarol. This is an advantage where the desideratum is the vanishing of the insecticide after it has done its job on infestations of plants, stored grain, etc. It is a disadvantage, however, where a prolonged prophylactic action is desired. In the presence of chalk and probably by special means of application (e.g., by impregnation of textiles) the lasting effect of Fluorgesarol can be prolonged. For mixing in the soil against soil insects the Fluorgesarol lasts appreciably longer than Gesarol.

(d) Bromgesarol is consistently inferior to Gesarol against all insects tested.

(14) Comment

The conclusions drawn above by Dr. Pfaff and Dr. Wagner are for the most part not justified by their testing data. A strong tendency to exaggerate the virtues of their own product in contrast to the Geigy Co. product is quite evident.

d. Pharmacological Testing of Gix

Dr. Dörzbach had prepared two reports on the pharmacological action of Gix on warm-blooded animals and on frogs.

(1) His first report dated 25 May 1943 is as follows:

A water emulsion containing 3% Gix,i.e., 1.8% 1-trichloro-2,2-bis(p-fluorophenyl) ethane, was sprayed in the amount of 140 cc into the air of a large room of 71 cu. m. capacity.

It was found that houseflies exposed in cages in the room on the third to fourth day after spraying were only slightly affected, while if exposed on the

first or second day, the flies were killed. Therefore it was decided to spray the room on every third day.

At the start of the experiment on 12 February 1943 the following animals were placed in the room:

1 small dog
2 cats
3 rabbits
3 capons
3 pigeons
6 guinea pigs
5 rats
10 mice
3 frogs

Several hours after the initial spraying the frogs died. A repetition of the experiment with frogs gave the same result. Of the 10 mice, 7 had died up to 24 May 1943. They died on the following dates: 16 February, 25 February, 27 February, 11 March, 16 March, 24 March, and 19 April 1943. The rats were all living on 25 May 1943. Of the 6 guinea pigs one died 14 days after the start of the experiment. The pigeons, capons and rabbits were all alive at the end of the first test period. One of the cats expired after 1 month. The dog was alive.

All surviving animals gained weight and exhibited no symptoms. Of the animals that died the mortality of the mice exceeded the normal; it was, however, about as great as among untreated mice of the same strain. One may conclude that the high mortality that was encountered exclusively among the mice was not a result of the treatment but was caused by an intercurrent sickness.

The experiment was continued until the warm summer months and further reported.

(2) Dr. Dörzbach's second report dated 14 September 1943 is as follows:

The spraying every third day was continued up to 22 July 1943.

The small growing dog gained 0.9 kg in weight. He was very lively and appeared to have suffered no ill effects. The blood picture of this animal was normal.

The surviving cat gained 1 kg in weight and was very lively. The blood picture of this animal was normal.

Of the 3 rabbits, 2 survived; they were lively and healthy-looking. They gained weight and had a normal blood picture. The third rabbit died of an unknown cause on 3 June.

Of the 3 capons, 1 died during a period of very hot weather; two survived.

Of the 3 pigeons, 2 were still in the

experiment; the third pigeon had to be removed on 8 June because of its belligerence towards the other 2 pigeons.

The 5 surviving guinea pigs were lively, healthy-looking and had produced healthy litters that developed normally. One guinea pig was sacrificed for the examination of its organs. No pathology was found.

The rats all survived. One rat was sacrificed for dissection. No pathology was found.

The results with the mice have already been reported. The mortality certainly was not a result of the experiment, but probably due to an infection, since the untreated animals of the same strain showed the same mortality.

From the foregoing results it was concluded that the toxicity of "Gix" under the conditions applied is not detectable. The ad exitum animals, almost without exception, died from causes that cannot be attributed to the insecticide preparation.

2. Use of "Gix" and DDT Preparations Against the Ox Warble

Dr. Wagner experimented with "Gix" and DDT in attempting to find a preparation that could be applied to cattle to prevent the ox warble (Hypoderma lineatum) from laying its eggs and to hinder the entrance of the newly emerged larva into the hide of the animal. As a result of preliminary trials against stable flies (Stomoxys calcitrans) in the stalls of the Parasitology Division at Höchst, he made up three preparations to be used on cattle and in the pasture. They were as follows:

a. Gix - 15% water emulsion.
b. Preparation 2494 containing
   20% 1-trichloro-2,2-bis(p-fluorophenyl) ethane
   10% paraffin wax
   70% UVM-oil (petroleum oil)
c. Preparation 2495 containing
   10% 1-trichloro-2,2-bis(p-chlorophenyl) ethane
   90% UVM oil (petroleum oil)

In August 1944 field tests were started on pasture cattle in the region of Hilders. Because of the yearly cycle of the ox warble larvae in the host the evaluation of the results of application in August 1944 was contemplated for the Spring or Summer of 1945. It was not possible for Dr. Wagner to examine the cattle, due to the conditions of war which prevailed.

3. "Nirosan"

a. Composition
   25% Tetranitro carbazole
   10% Sulfite pulp
   0.25% Wetting agent ("Igepal")

The remainder is inert material, i.e., kaolin and chalk.

b. Preparation of Active Ingredient

Carbazole is nitrated with nitrating mixture to give 1, 3, 6, 8-tetranitro carbazole. 100 kg carbazole yields 170 kg of the tetranitro compound.

c. Use

The chief use of this insecticide has been in vineyards. It is claimed to be a good substitute for arsenic insecticides against the first and second generation of the vine moth.

4. "Dizan"

a. Composition

2.5% N-(phenyldiazo) piperidine
97.5% talc

b. Preparation of Active Ingredient

Aniline is diazotized and coupled with piperidine.

c. Use

It is claimed to be very effective against cockroaches and is non-toxic to man and domestic animals.

5. "Raupenleim (Caterpillar glue)

a. Composition

80.7% chlorinated "Kogasin"*
15.0% oxycresyl camphane
0.8% Phenoxy propenoxide
3.5% I. G. Wax S

*Kogasin is a mixture of aliphatic hydrocarbons from synthetic gasoline which has been chlorinated to 52% chlorine content.

Oxycresyl camphane is made by condensation of cresol with camphane.

Phenoxy propenoxide, $C_6H_5OCH_2-\overline{CH}-\overline{O}-CH_2$ is added as a stabilizer to inhibit the splitting out of HCl from the "Kogasin".

b. Use

It has been used to trap the larvae of the winter moth. It is applied to the bark of fruit trees.

III. FUNGICIDES

1. 2317W

a. Composition

15.0% 1-thiocyano-2,4-dinitrobenzene
2.5% Cu in the form of copper oxychloride
1.5% "Makulatur 1093 b"*
11.0% Sulfite pulp
The rest is kaolin and chalk.

* "Makulatur 1093 b" contains 11% oxidized methyl cellulose, 89% kaolin plus sticking agent.

b. Preparation of Active Ingredient

1-Thiocyano-2,4-dinitro benzene, m.p. 138°, is prepared by treating 1-chloro-2,4-dinitrobenzene with NH_4SCN in the aqueous phase in the presence of a wetting agent.

c. Use

It is claimed to be very effective against Peronospora in vineyards and on hops; it is also effective against Phytophora of potatoes.

2. "Brassicol" and "Tritisan 5"

a. Composition

(1) Brassicol contains 20% pentachloronitrobenzene plus 80% talc.

(2) Tritisan-5 contains 15% pentachloronitrobenzene plus 83% talc plus 2% maschine oil.

b. Preparation of Active Ingredient

Nitrobenzene is chlorinated in chlorosulfonic acid using iron and iodine as catalysts.

c. Use

(1) Brassicol is used as a soil disinfectant and against Salatfäule (a disease of lettuce).

(2) Tritisan-5 is used as a dry seed dressing against stinking smut of wheat (Weizensteinbrand).

3. "Bulbosan"

a. Composition

7.5% 1, 3, 5-trichloro-2, 4, 6-trinitrobenzene
92.5% talc

b. Preparation of Active Ingredient

The trichloro-trinitrobenzene, because of its explosive properties, has been made only in limited quantities by nitration of 1, 3, 5-trichlorobenzene.

c. Use

It is reported to be extremely effective in controlling tomato leaf mold (Cladosporium fuloum).

4. "Brassisan"

a. Composition

20% 1,2,4-Trichloro-3,5-dinitrobenzene
3% Maschine oil
77% Talc

b. Preparation of Active Ingredient

1,2,4-Trichloro-3,5-dinitrobenzene is prepared by nitration of 1,2,4-trichlorobenzene.

c. Use

It is claimed to be very effective in controlling finger and toe club root (Kohlhernie) of cabbage plants.